



# 1999 FCRPS Asset Management Strategy Implementation Results

Northwest Hydro Operators Forum  
Stevenson, WA  
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# Background



In 1999, BPA produced the first FCRPS Asset Management Strategy. Its overall goal was to **maximize the value of the FCRPS**.

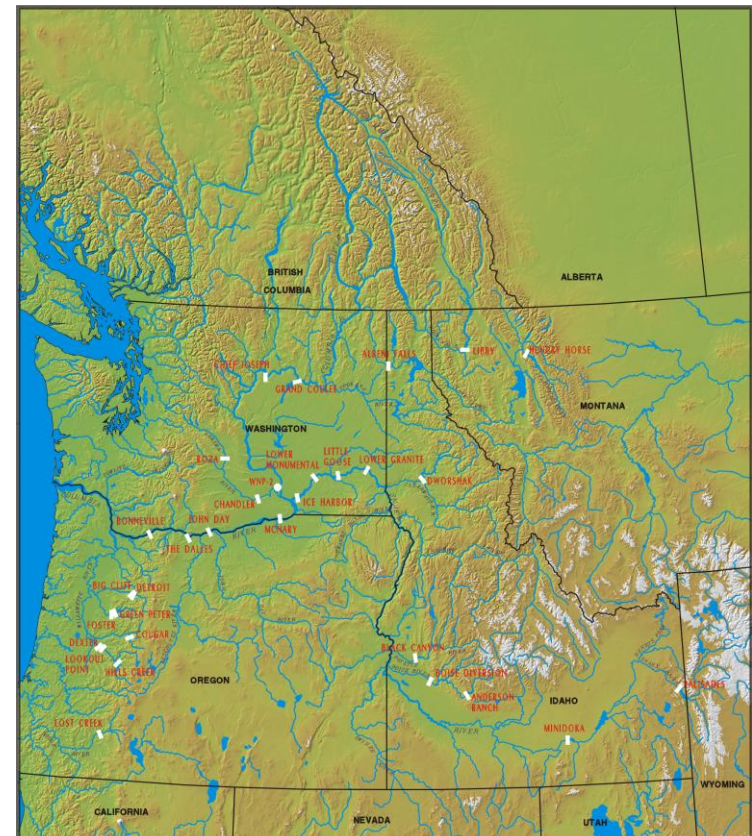
To develop the strategy, BPA convened a multiagency team from:

- The Army Corps of Engineers;
- Bureau of Reclamation;
- Washington Public Power Supply System (now Energy Northwest); and,
- Harza Engineering (now part of MWH).

The team stated two objectives for the strategy:

- Objective #1: Establish the level of power and joint-use investments needed to **restore reliability** of the FCRPS to industry standards or better; and,
- Objective #2: Assess the ability of the FCRPS to **enhance revenues** by at least \$50 million per year.

## Asset Management Strategy for the Federal Columbia River Power System



## How Much Would it Cost?

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The team identified \$1.26B (\$975m in year-2000 dollars) in large capital over a 13 year period to meet the two strategy objectives.

- Objective #1: \$1.07B (\$825m in year-2000 dollars) to **restore the reliability** of the FCRPS to industry standards or better, defined as a system availability factor of 90 percent.
- Objective #2: An additional \$186m (\$150m in year-2000 dollars) in turbine runner replacements, head sensing, turbine indexing, and system optimization to **enhance revenues** by at least \$50m per year.

We spent \$1.32B from 2000 through 2012, close to what was forecasted.

- \$1.13B on restoring reliability
- \$187m on efficiency improvements to enhance revenues

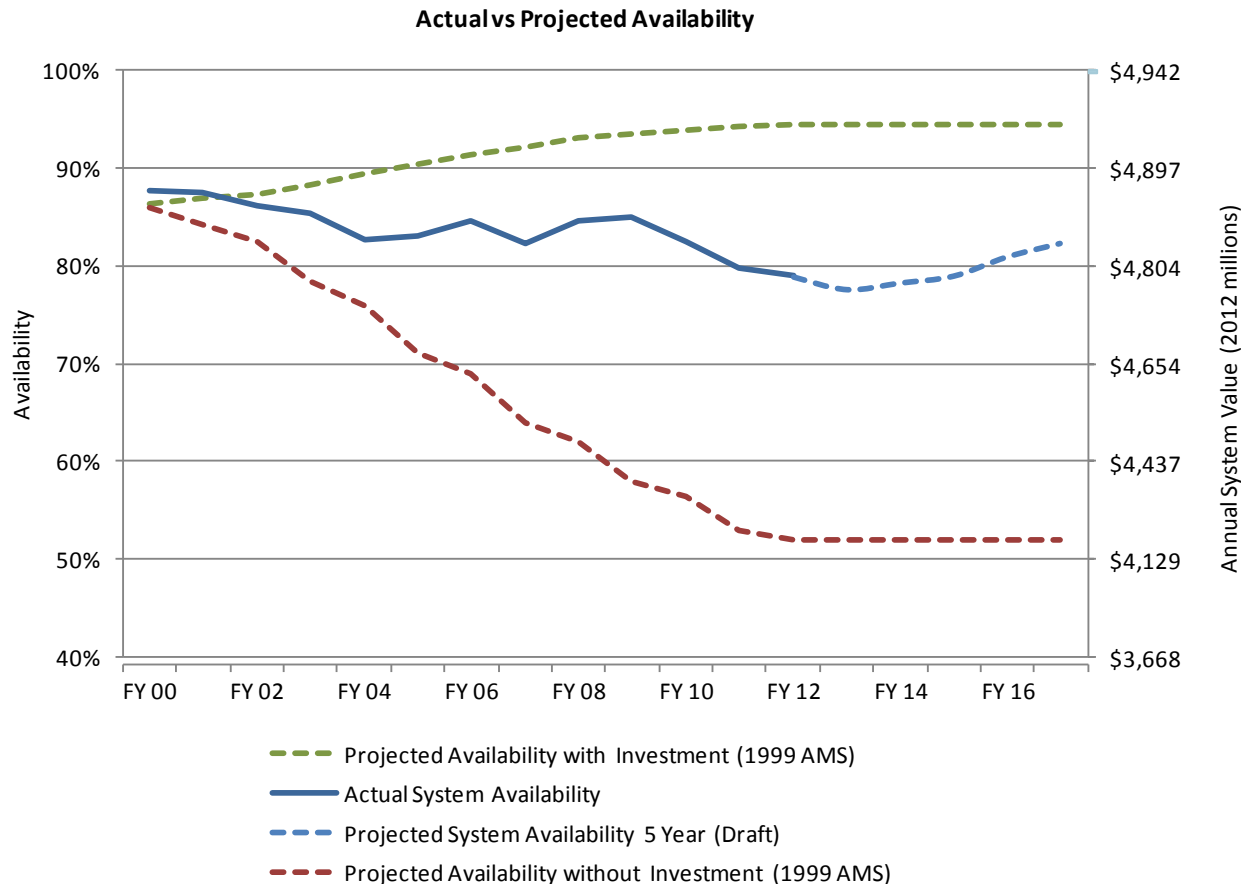
# Investment Activity Since 1999

## As of 10/01/2011



	Turbines	Governors	Exciters	Generators	Breakers	Transformers	Cranes	Station Service	Water Passage
<b>Main Stem Columbia</b>									
Bonneville	x		x	x	x		x		x
Chief Joseph	x		x		x				
John Day			x	x	x		x		
McNary	x		x		x	x	x	x	x
The Dalles			x	x	x	x	x	x	
Grand Coulee	x		x	x	x	x			x
Total Main Stem Columbia									
<b>Headwater/Lower Snake</b>									
Dworshak			x		x	x			
Ice Harbor	x		x	x	x		x		
Libby			x		x		x		
Little Goose			x		x		x		
Lower Granite			x		x		x		
Lower Monumental			x		x	x	x		x
Hungry Horse			x		x	x			
Total Headwater/Lower Snake									
<b>Area Support</b>									
Albeni Falls			x		x		x		x
Cougar			x	x	x				
Detroit-Big Cliff			x	x	x				
Green Peter-Foster			x	x	x				x
Hill Creek			x	x	x				x
Lookout Point-Dexter	x		x	x	x				
Lost Creek			x		x				
Minidoka-Palisades			x		x			x	
Total Area Support									
<b>Local Support</b>									
Boise Diversion-Anderson Ranch-Black Canyon			x	x	x	x			x
Chandler-Roza			x		x				
Green Springs			x		x				
Total Local Support									
<b>Total (Completed and Underway)</b>	<b>62</b>	<b>41</b>	<b>111</b>	<b>88</b>	<b>261</b>	<b>102</b>			

# FCRPS System Availability 2000 – 2017



- With 1999 AMS investments, we projected availability would improve to 90% by 2005 and to 95% by 2012. A bit optimistic, given that significant outages were needed for both investment and maintenance.
- Actual availability has remained in the 80% to 85% range, largely attributable to high maintenance outages.
- Without investment, availability was projected to decline from 86% in 2000 to 52% in 2012.
- The difference between the bottom two curves represents an avoided generation loss associated with implementing the strategy, which forms the basis for reliability benefits derived in this analysis.

# Results: Restoring Reliability (Objective #1)

Investment FY00 – FY12: \$1.13B in large capital, primarily on power train equipment.

Total for the 13-year period is **\$64m more than forecasted** in the strategy.

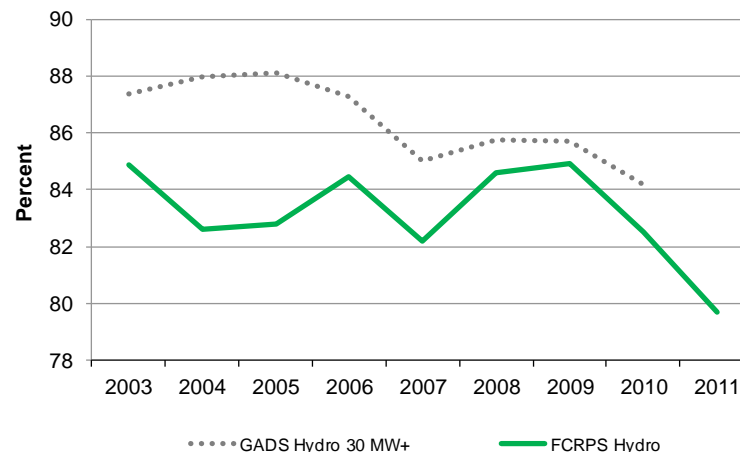
## Average **weighted availability factor**

- FCRPS 84% in 1998 to 82% in 2010
- Industry average 90% in 1998 to 84% in 2010

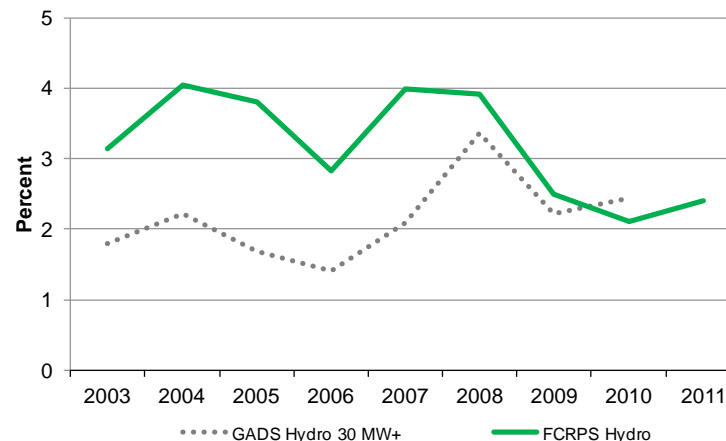
So, while the FCRPS has closed the gap on restoring availability to the current industry standard, it has yet to reach a targeted weighted availability factor of 90% or higher largely because of the continuing need to invest in the system but also due to a **high weighted scheduled outage rate for routine maintenance**, which has exceeded 10% in each of the past two years.

The **weighted forced outage factor** for the FCRPS declined from 6% in 1998 to 2.1% in 2010, below the 2010 industry average of 2.4%.

## Weighted Availability Factor (WAF)



## Weighted Forced Outage Factor (WFOF)



## Results: Enhancing Revenues (Objective #2)

Investment FY00 – FY12: \$187m in efficiency improvements, including

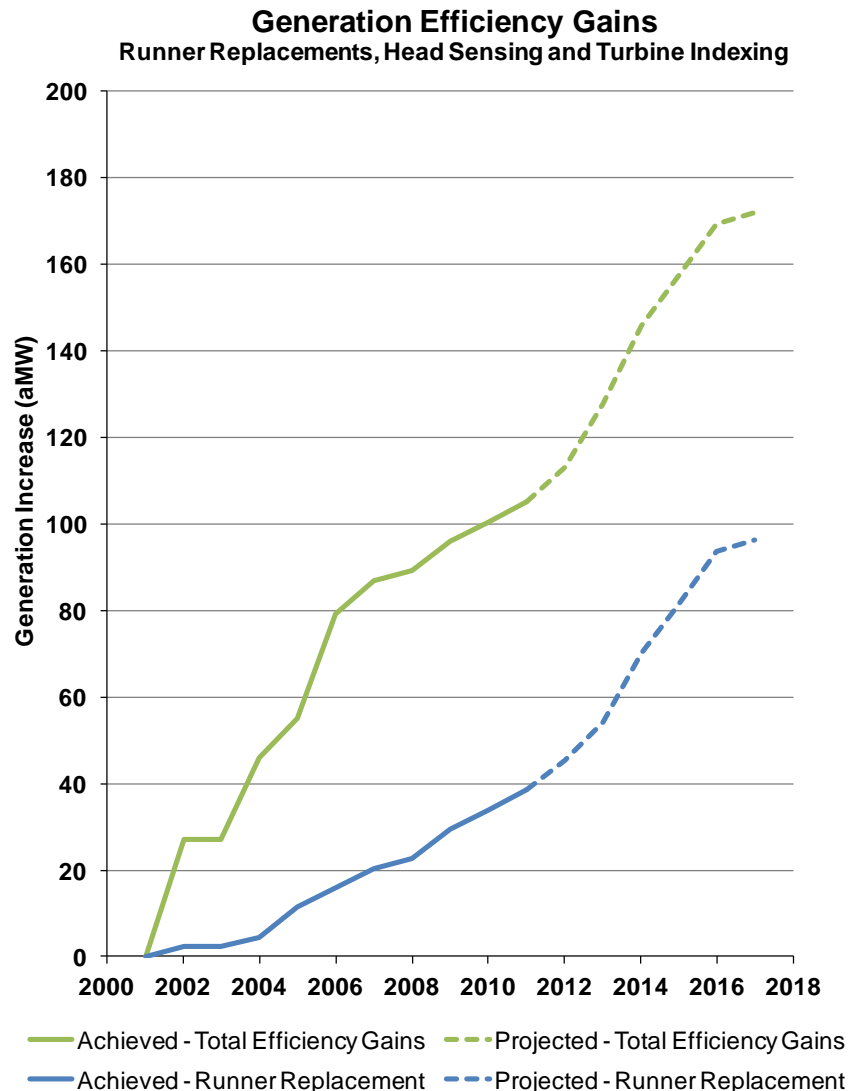
- Runner replacements at Grand Coulee,
- Head sensing and turbine indexing at Lower Columbia River and Lower Snake River plants,
- Implementation of Near Real Time Optimization (NRTO) software at regulated plants.

**\$1m more than forecasted in the strategy**

Benefits through 2011:

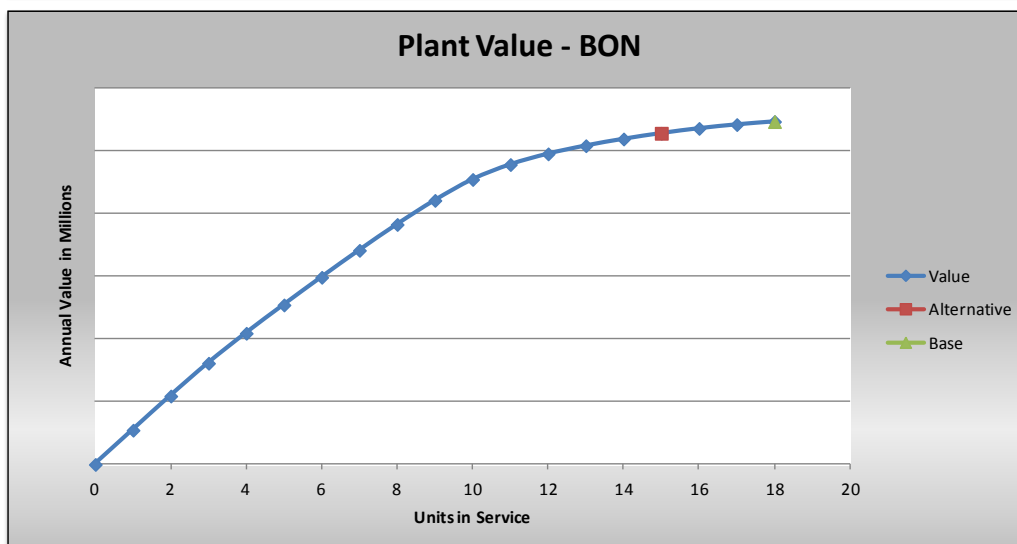
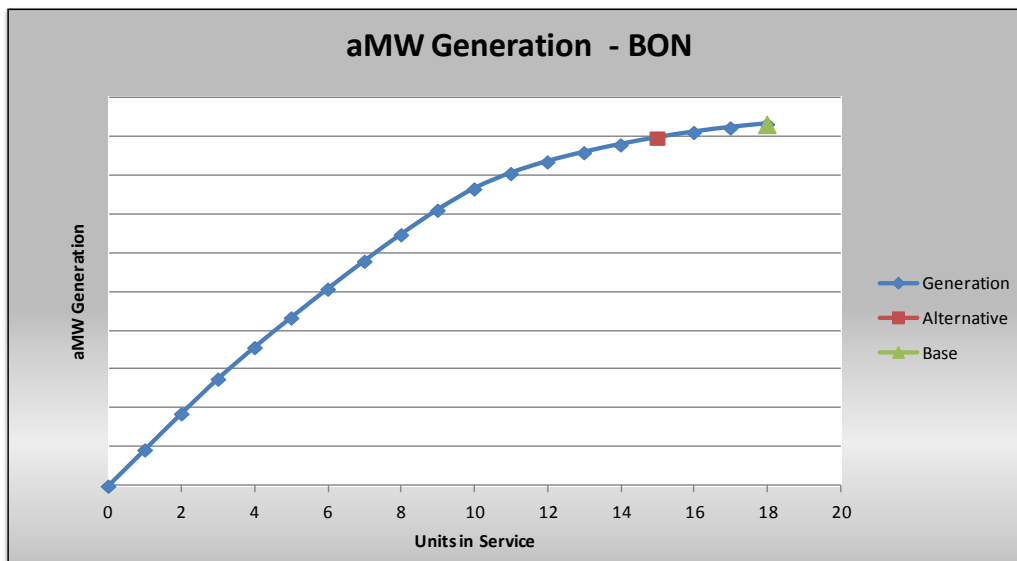
- **105 aMW** in increased generation (excludes NRTO gains which cannot be verified because of changing operational requirements).
- Worth \$60m per year at forecasted forward energy and capacity prices.
- **Exceeds the strategy objective** of increasing revenues by at least \$50m per year.

Another **67 aMW** in efficiency improvements is forecasted through 2017, primarily from Chief Joseph runner replacements.





# Valuing Objective #1 Investments: Restoring Reliability

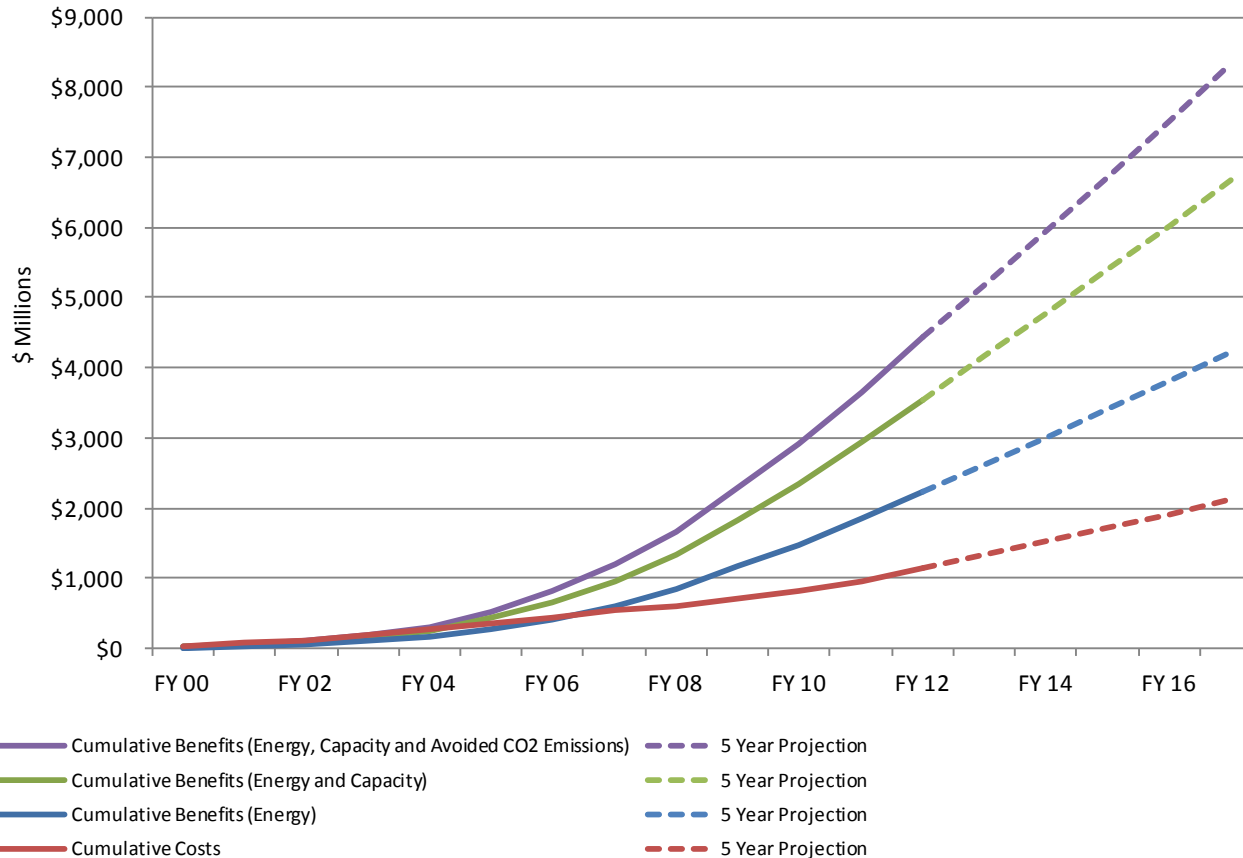


- Hydro regulation studies are run to calculate energy that can be generated at each FCRPS plant with 100% turbine hydraulic capacity for each month in an 80-year water record (Green triangle in top graph).
- Monthly energy contents are then shaped into heavy and light load periods using factors derived from an hourly capacity model.
- The resulting energy content is then valued at BPA's rate case forward price forecast to determine the value of a plant at 100% availability (Green triangle in bottom graph).
- Model runs are then repeated at lower turbine hydraulic capacity levels to derive new energy contents and annual values (Red squares).



# 1999 Strategy Cumulative Reliability Investment Benefits and Costs

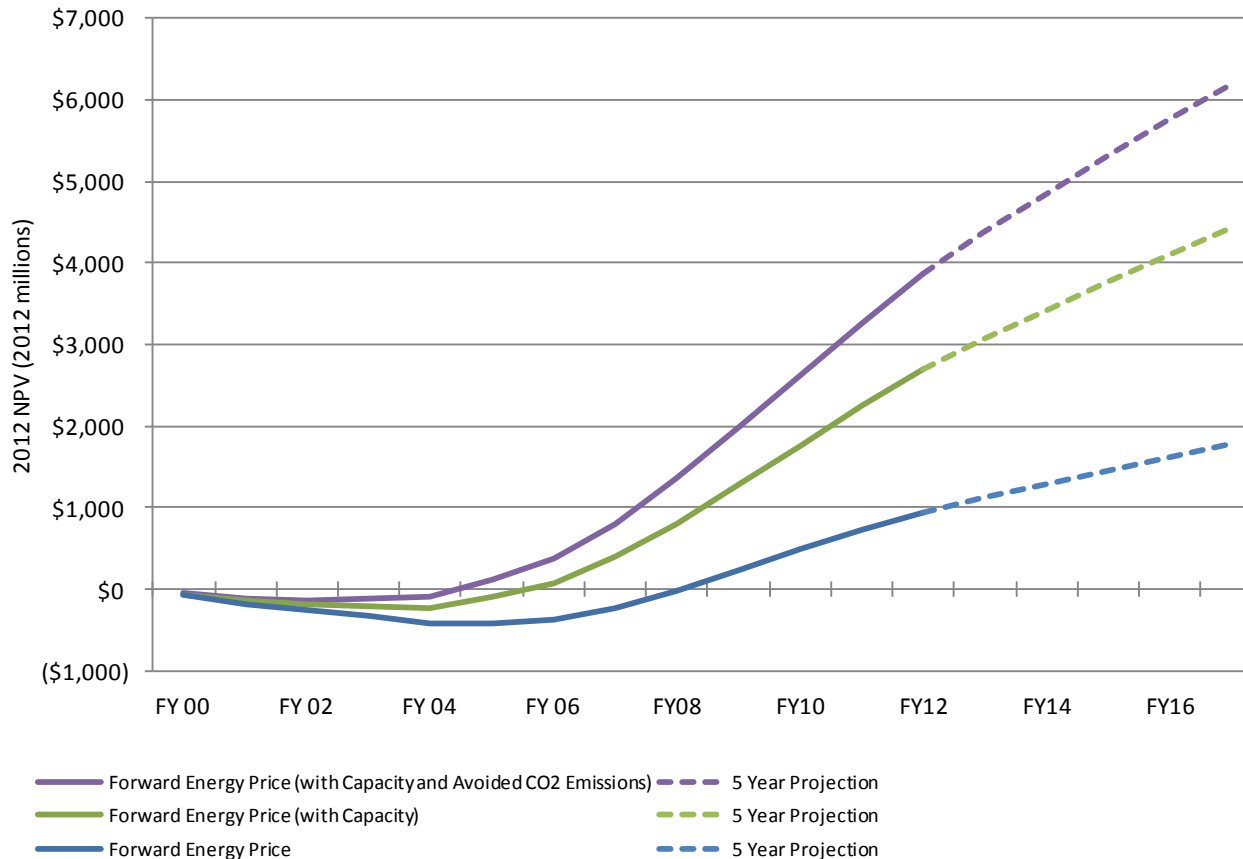
(Undiscounted Nominal Dollars)



- Cumulative costs and benefits for three different energy price forecasts are shown.
- The **Red** line shows cumulative investment costs incurred since 2000 for restoring reliability.
- The **Blue** line represents cumulative benefits realized from implementing the strategy using the **2014-2015 Rate Case Forward Energy Price Forecast**.
- The **Green** line adds a capacity value to the energy price forecast.
- The **Purple** line adds an avoided CO2 emissions benefit for hydro to the energy and capacity price forecast consistent with CO2 costs included in the Council's 6<sup>th</sup> Power Plan (\$41/ton CO2).

# 1999 Strategy Reliability Investment Net Benefits

(2012 Net Present Value of Benefits minus Cost)



- Cumulative net benefits (present value of benefits minus costs) at three different energy price forecasts are shown.
- The **Blue** line represents cumulative net benefits realized from implementing the strategy using the **2014-2015 Rate Case Forward Energy Price Forecast**. Cumulative net benefits to date are \$950m.
- The **Green** line adds a capacity value to the energy price forecast, resulting in net benefits to date of \$2.7B.
- The **Purple** line adds an avoided CO2 emissions benefit for hydro to the energy and capacity price forecast consistent with CO2 costs included in the Council's 6<sup>th</sup> Power Plan (\$41/ton CO2). Net benefits to date are \$3.9B.

# Conclusion

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The 1999 strategy was a good blueprint for the hydro program. We largely delivered on the strategy objectives, having mixed results on restoring reliability of the system, but exceeded our goal of assessing and securing efficiency improvements that enhance revenues.

Investment in the system is not “done”. While much equipment has been rebuilt or replaced, other equipment is becoming less reliable and in need of attention. Availability is still below targeted levels. The system continues to age and reinvestment will be needed on an ongoing basis. Determining where and when to make these investments is a key challenge for asset management.

The FCRPS hydro program is now at a point where it needs to refine its direction for the next 10 or more years, starting with a few strategic objectives similar to those developed for the 1999 strategy. A process to define these objectives is now underway.



Thank you

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